Industrial Organization 10

Networks and Standards

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Structure

1. Network industries characteristics
2. Intra-group network effects, consumer expectations and critical mass
3. Cross-group network effects in two-sided markets
4. Standards wars
   - Standards competition and the “lock-in” effect
   - Adoption of new technologies
   - Standards competition and compatibility choices
   - Public policy

Network Industries

Some goods or services are characterized by network externalities or network effects (or club effects).

Definition of network effects

A good or a service is subject to network effects if the benefit (utility) for a given consumer depends on the number (or intensity of usage) of other consumers.

We can have positive or negative network effects.

- Positive: the utility increases with the number of users
- Negative: the utility decreases with the number of users

Network Industries

We call network industries industries in which the products or services exhibit network effects.

Examples:

- Communication networks: Telephone, fax, email, instant messaging
- Video games
- Media
- Banking services
- ...

Network Industries

Common features between these network industries:

- Complementarity between different inputs
- Importance of standards
- Switching costs" and "lock-in" effects
- Economies of scope

→ These industries cannot be competitive. We observe a low degree of competition in the market structure (monopoly or oligopoly).

Consumer Expectations and Critical Mass

With network effects, the utility of a consumer depends on the network size, or more exactly, on the expected size (i.e. on the *expectations* of the consumers).

An example:

- 1 million consumers wonder whether to adopt a new technology which exhibits network effects
- For each consumer, the value of the technology = the number of user, n
- If the price is p, the consumer adopts if $p \leq E[n] = n^e$

Consumer Expectations and Critical Mass

In this game, if $p > 0$ and $p < 1000000$, there is at least one Nash equilibrium.

No consumer adopts the product

- Let's assume that $n^e = 0$
- For all $p > 0$, the net benefit in case of adoption is negative
- So no consumer adopts and $n = n^e = 0$
- Rational anticipations

All consumers adopt the product

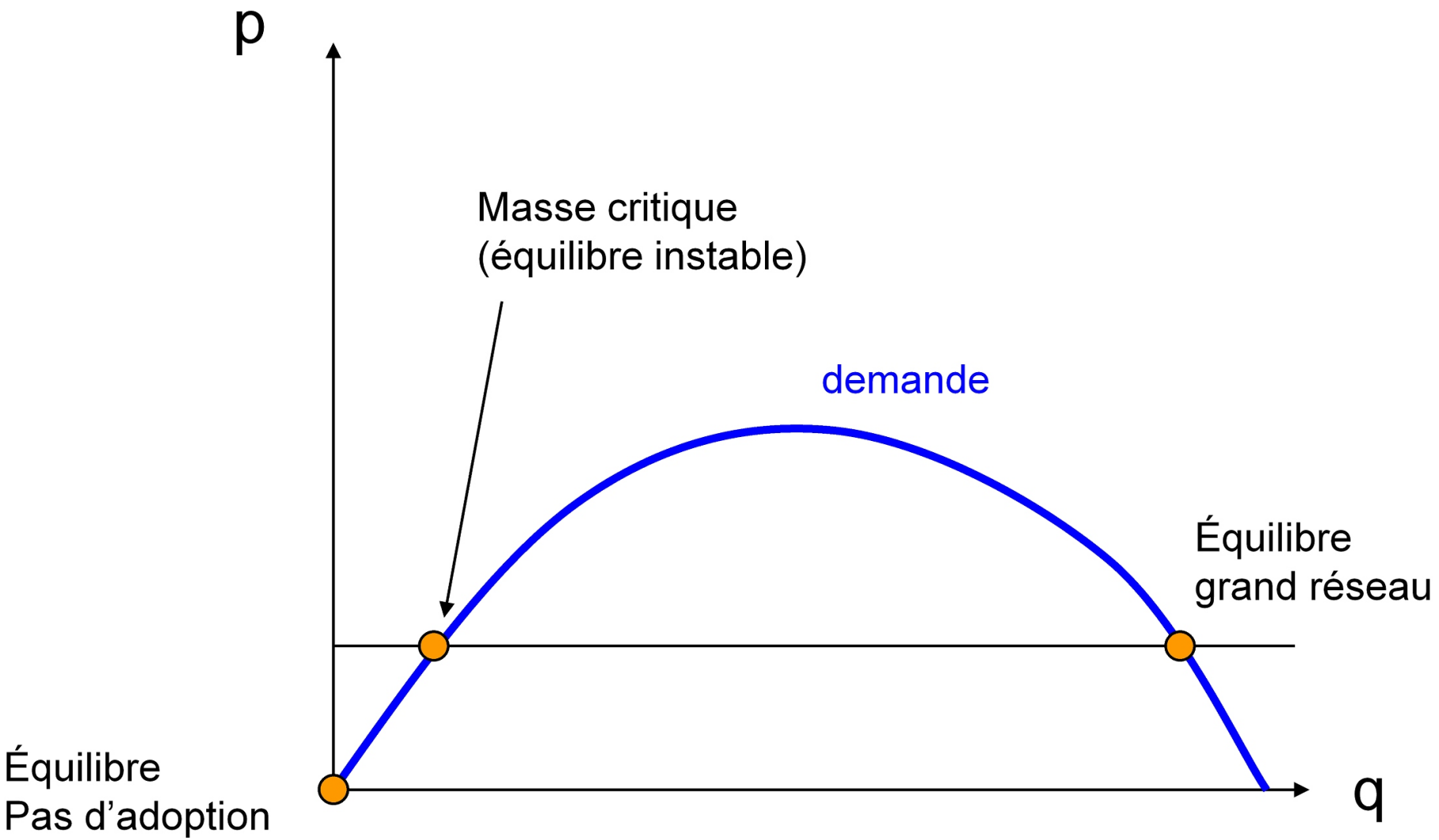
- Let's assume that $n^e = 999.999$
- As long as $p \leq 999.999$, every consumer wishes to adopt the product
- Therefore, all consumers adopt the product
- And $n = n^e = 999.999$

Consumer Expectations and Critical Mass

Critical mass

- Let's assume that $p = 900$
- 900 consumers have an intrinsic value ≥ 900 for the product
- What happens?
- All these 900 consumers adopt the product
- It becomes then interesting for all other consumers to purchase the good
- The demand converges, therefore, toward an equilibrium of big network
- We qualify this threshold (900) of "critical mass"

Consumer Expectations and Critical Mass



Consumer Expectations and Critical Mass

Competitive market

- Let's take a product whose cost decreases over time
- Produced in a competitive market
- At first only consumers with a high willingness-to-pay purchase the product
- When the cost has sufficiently decreased, the critical mass is reached and the network develops quickly

Monopoly market

- A monopoly firm could have incentives to set a very low price (introductory price) to trigger an adoption dynamic
- "Snowball" effect

Two-sided Markets

We usually distinguish two types of network effects:

- Direct effects or intra-group
- Indirect effects or inter-group (or cross-group)

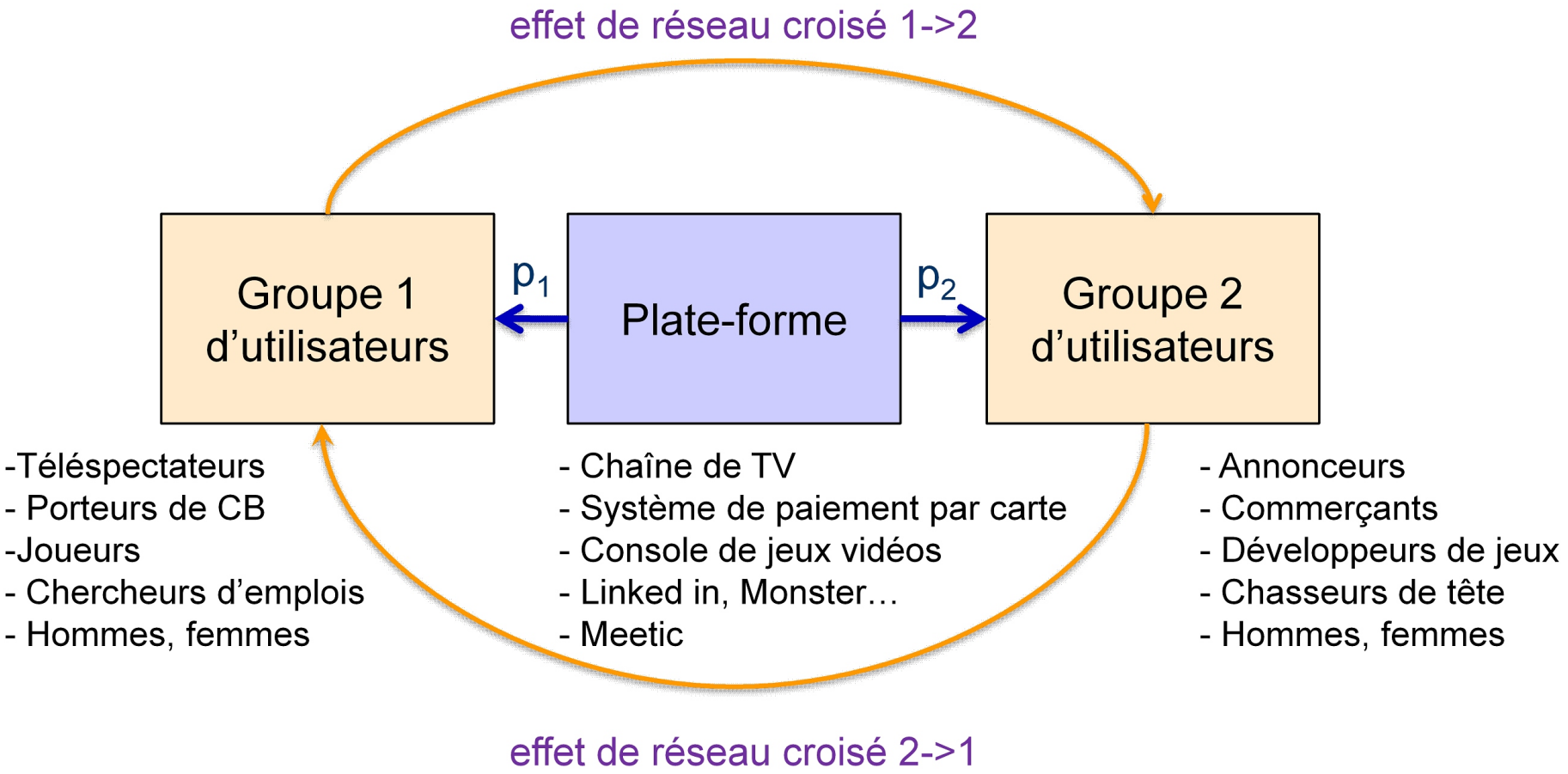
In some markets, some platforms connect up two (or more) groups of users linked by inter-group network effects.

We qualify these markets of two-sided markets.

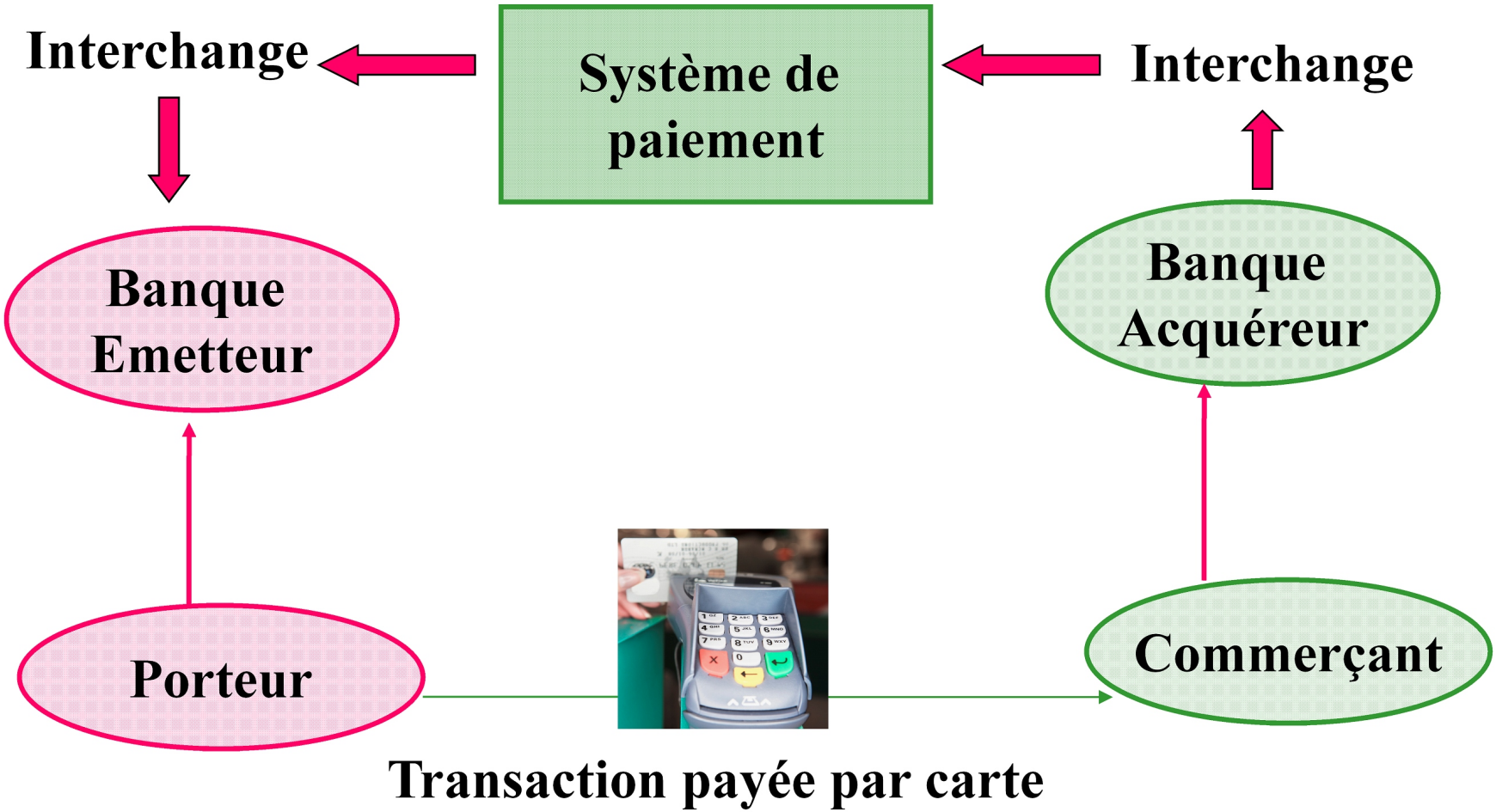
Some examples:

- Media
- Payment systems
- Video games, operating systems
- Matching platforms

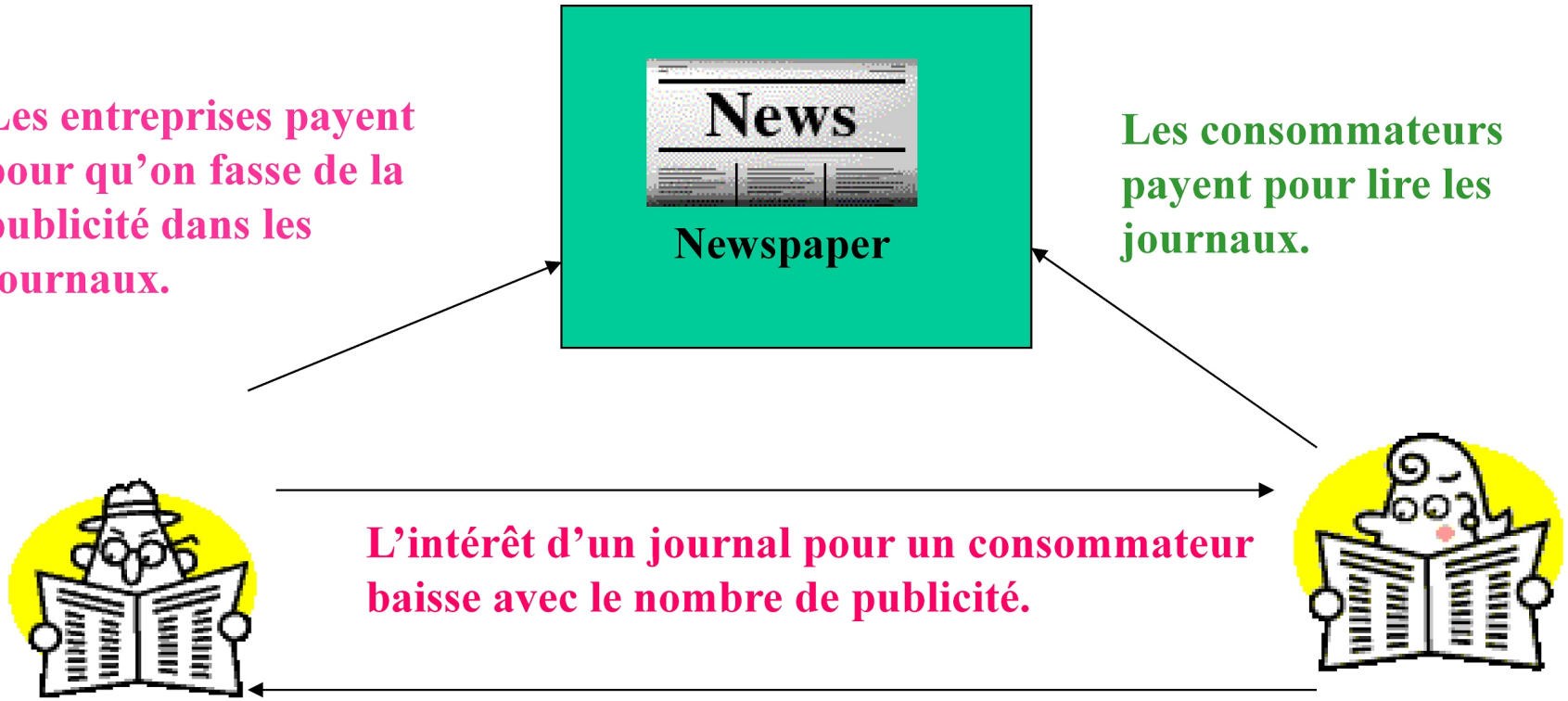
Two-sided Markets



Two-sided Markets: Payment Systems



Two-sided Markets: Newspapers



Two-sided Markets

Two-sided markets characteristics:

Asymmetric pricing

The platform tends to set a lower price on the market side which generates the most network effects.

Fierce competition between platforms

...because losing one customer on one side of the market implies losing other customers on the other side.

Influence of the choice to connect with competitive platform

The competition between platforms highly differs depending if customers are connected to all platforms (multi-homing) or only one (single-homing).

Standards Competition

A standard

When one unique technology tends to impose on the market.

→ It's the case with network effects.

In a market with network effects, firms will start a standards war. Example:

- VHS vs Betamax
- Blu-ray vs HD-DVD
- Keyboards (QWERTY)...

Standards Competition

Let's assume there are two versions of the same technology: version A and version B.

Consumers arrive sequentially on the market and have a preference either for A or for B:

- For A "lovers": $U = v + n_A$ for product A and $U = n_B$ for product B
- For B "lovers": $U = n_A$ for product A and $U = v + n_B$ for product B
- With $v > 0$
- The two product prices are assumed fixed and identical

Which technology (standards) will eventually win?

Standards Competition

Adoption choice

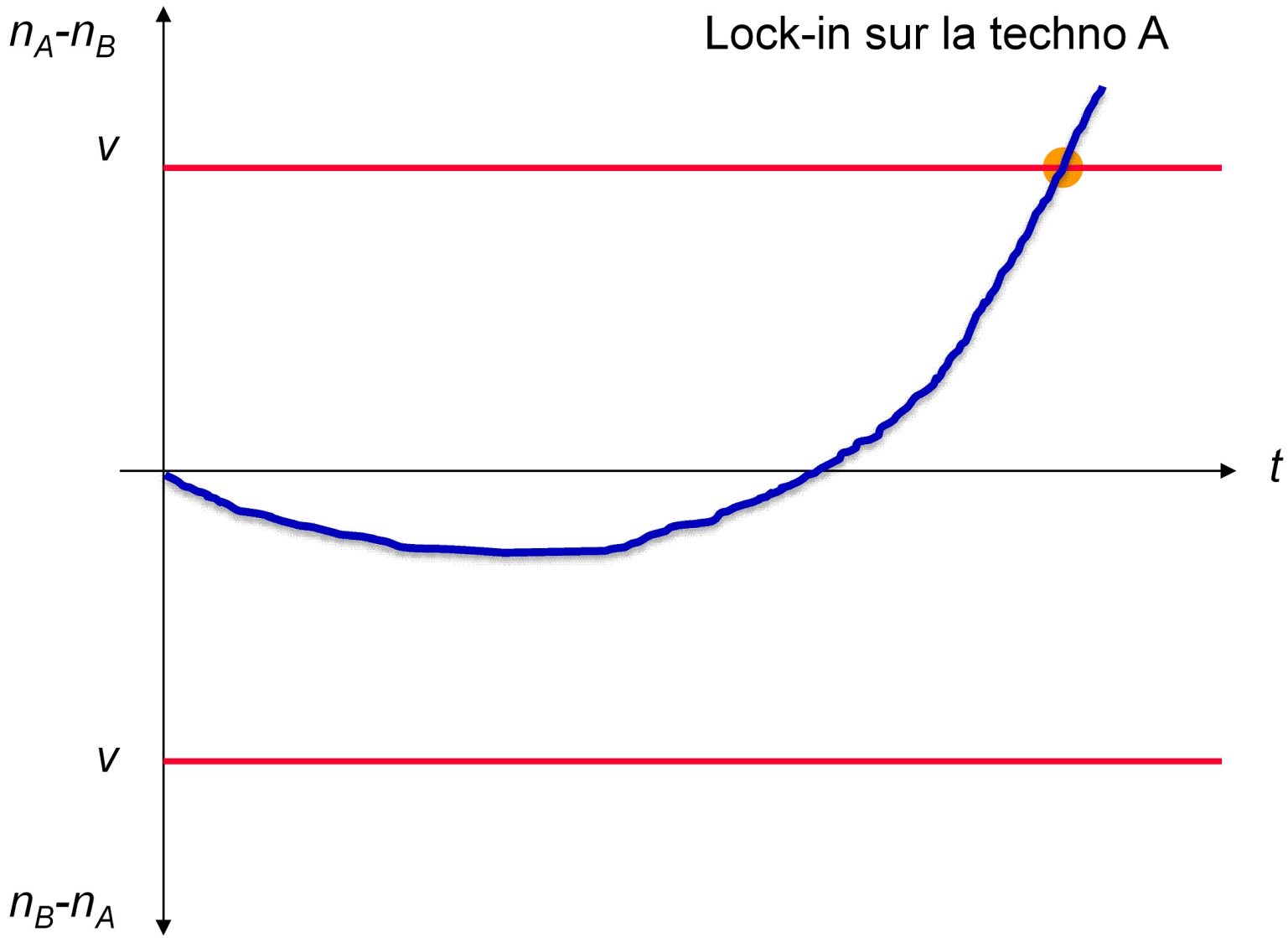
- A lovers chooses product A rather than B if $v + n_A \geq n_B$
- i.e. if $n_B - n_A \leq v$
- Therefore: as long as $|n_A - n_B| \leq v$, A lovers adopt product A and B lovers, product B
- If $n_A - n_B > v$, B lovers adopt product A
- If $n_B - n_A > v$, A lovers adopt product B

$|n_A - n_B| > v$ happens with a non-zero probability. From this point, we talk about (feedback effect) and lock-in effect.

We can have an inefficient lock-in (on the wrong technology).

There is also a path dependency, which provides a particular property to goods with externalities.

Standards Competition



An Example of Standards War: VHS vs. Betamax

- The video recorder has been invented in 1956 by Ampex (sold at more than 50.000$)
- From the 1950s onwards, research to produce a video recorder for the general public: Ampex in the US, Philips in Europe, Japan Victor and Matsushita in Japon
- 1971: U-Matic technology from Sony. First step, but technology still too expensive for households.
- 1975: Betamax introduction by Sony
- 1976: VHS introduction by JVC and Matsushita
- Other alternative formats: Ampex, RCA, Toshiba, Sanyo, Philips
- But competition essentially between VHS and Betamax, two technologies based on U-Matic
- So weak technological differentiation

An Example of Standards War: VHS vs. Betamax

	BETA FORMAT			VHS FORMAT		
Year	(A)	(B)	(C)	(A)	(B)	(C)
1975	20	20	100/100	--	--	--
1976	175	195	61/64	110	110	39/36
1977	424	619	56/58	339	449	44/42
1978	594	1,213	40/48	878	1,327	60/52
1979	851	2,064	39/44	1,336	2,663	61/56
1980	1,489	3,552	34/39	2,922	5,585	66/61
1981	3,020	6,572	32/35	6,478	12,063	68/65
1982	3,717	10,289	28/32	9,417	21,480	72/68
1983	4,572	14,861	25/30	13,645	35,125	75/70
1984	6,042	20,903	20/26	23,464	58,589	80/74
1985	3,387	24,290	8/20	40,977	99,566	92/80
1986	1,106	25,396	4/16	29,553	129,119	96/84
1987	669	26,065	2/13	39,767	168,886	98/87
1988	148	26,213	0.3/11	44,761	213,647	99.7/89

An Example of Standards War: VHS vs. Betamax

VHS GROUP (40)

Japan Victor
Matsushita
Hitachi
Mitsubishi
Sharp
Tokyo Sanyo
Brother (Mi)
Ricoh (H)
Tokyo Juki (H)
Canon (Ma)
Asahi Optical (H)
Olympus (Ma)
Nikon (Ma)
Akai
Trio (J)
Sansui (J)
Clarion (J)
Teac (J)
Japan Columbia (H)
Funai

Magnavox (Ma)
Sylvania (Ma)
Curtis Mathes (Ma)
J.C. Penny (Ma)
GE (Ma)
RCA (H)
Sears (H)
Zenith (J)*

Blaupunkt (Ma)
Zaba (J)
Nordmende (J)
Telefunken (J)
SEL (J)
Thorn-EMI (J)
Thomson-Brandt (J)
Granada (H)
Hangard (H)
Sarolla (H)
Fisher (T)
Luxer (Mi)

BETA GROUP (12)

Sony
Sanyo
Toshiba
NEC
General (To)
Aiwa
Pioneer (S)

Zenith (S)*
Sears (Sa)

Kneckerman (Sa)
Fisher (Sa)
Rank (To)

An Example of Standards War: VHS vs. Betamax

Success and failure factors:

- Aggressive alliance strategy from JVC/Matsushita, in particular on European markets
- Important capacity production from Matsushita
- Sony's refusal to produce video recorders with a white label, whereas JVC/Matsushita agreed
- More pre-recorded video on VHS

Inertia or Precipitation?

Do technological changes happen at the right moment when network effects are at play?

Let's assume there is an old technology (**O**(ld)) and a new technology (**N**(ew)) and two users who both use technology O.

Both users should decide sequentially whether to switch toward technology N.

- A user is: either O lover or N lover.
- He knows his type, but not the one of the other user
- There is also a positive network effect

Inertia or Precipitation?

Payoff for a type N user (line), given the choice of the other user (column)

	O	N
O	12	10
N	-10	17

Payoff for a type O user (line), given the choice of the other user (column)

	O	N
O	10	9
N	-20	-8

If there is a probability of 80% that a user is a type N user, what is the equilibrium?

Excess Inertia

Let's assume that there is a probability of 80% that a user is a type N user.

Second user's decision

- If type O: choose to keep technology O
- If type N: adopts N if and only if the first user has chosen N

First user's choice

- If type O: keep O
- If type N:
  - If the second is a type O, it will choose O
  - If it is a type N, it will choose N
  - So, if the user chooses O: U=20% * 12 +80%*12=12
  - If the user chooses N: U=20%*(-10)+80%*17=11.6
  - So user 1 of type N chooses O

Excess Inertia

Conclusion

Even though there is a high preference for the new technology N, at the equilibrium, there is no switch toward the new technology.

We talk about excess inertia.

This result (excess inertia) is not general. We can also have an excess speed of adoption (excess momentum).

Excess Momentum

Payoff for a type N user (line), given the choice of the other user (column)

	O	N
O	12	10
N	-10	13

Payoff for a type O user (line), given the choice of the other user (column)

	O	N
O	100	4
N	-20	5

Probability of a user to be a type N is 1%.

Compatibility Choice

Let's consider two technologies A and B with network effects:

- If the products are incompatible, the product utility i is n_i ($i = A, B$), i.e. the number of product i users
- If both products are perfectly compatible, the utility of A or B is $n_A + n_B$

Competition to become the standard

- If a firm wins the standard war, its utility is π^M
- If a firm looses, its profit is 0
- If firms agreed on a common standard, their profit is π^D

Compatibility Choice

Firms spend resources to get the market

- It is as if we had an auction
- Each firm will spend until π^M to get the market
- The expected net profit is equal to zero
- Firms would come out better off to sign an agreement on a common standard

The winning standard is randomly selected

- Let's assume that each firm has a probability of 50% to win the standard
- Firms will compete as soon as $\pi^M > 2\pi^D$
- It is usually the case (efficiency effect)

Compatibility Choice

Conclusion

- If the standard war is fierce, firms prefer compatibility: they prefer to agree on compatible technologies (competition in the market)
- If there is a fierce competition on the product market, firms prefer the incompatibility: they prefer to enter a standard war (competition for the market)

Public Policy

Network externalities are an example of market failure where public intervention could be beneficial.

Public policy can promote standardization:

- Advantages: Bigger networks, so more network effects
- Costs: less competition, less product varieties

Example of standardization decision: mobile phone

- Standardization for Europe: GSM, UMTS
- No standardization in the US: compatibility problem at first, but fiercer competition

Public Policy

The absence of standardization can be costly, in particular in terms of adoption time (*excess inertia*).

Example: standard war between Blu-Ray and HD-DVD.

A difficulty fo public policy: the information required to decide *which* technology to promote, *when* to promote adoption, etc.

Take-Aways (1)

- Network industries are characterized by adoption externalities, compatibility problems and standards, important switching costs for consumers and economies of scale.
- There are intra-groups externalities (club effects) and crossed-externalities in the platforms, also called two-sided markets.
- The network cannot work without a critical mass of consumers. Therefore, the firm will try to influence the agents to convince them to adopt the technology or the product.

Take-Aways (2)

- Competition between standards lead to feedback effects and lock-in effect.
- Due to the existence of network externalities, technologies used in network industries could be adopted with too much precipitation or too much inertia.
- When the standard war is too fierce, firms prefer to agree on compatible technologies. If competition on the product market is too fierce, firms prefer to enter a standard war.
- Network externalities are an example of market failure where public intervention could be beneficial.